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Is high-concentration oxygen therapy more effective than targeted oxygen therapy in neonatal non-tension pneumothorax?

Anna Gregory,¹ Andrew Keith Ewer,^{1,2} Anju Singh.¹ *

1. Neonatal Unit, Birmingham Women's and Children's NHS Foundation Trust, Edgbaston, Birmingham, B15 2TG. UK.

2. Institute of Metabolism and Systems Research, University of Birmingham, B15 2TT. UK.

*Corresponding Author: Dr Anju Singh, Neonatal Unit, Birmingham Women's and Children's NHS Foundation Trust, Edgbaston, Birmingham, B15 2TG

Email: anjusingh@nhs.net

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Clinical scenario

A term new born is admitted to the neonatal unit with positive pulse oximetry screen¹ and tachypnoea. The respiratory rate is 70 breaths per minute but there are no other signs of respiratory distress. The pre-ductal pulse oximeter oxygen saturations (SpO₂) are 91% and post-ductal SpO₂ are 90% in room air. The baby is commenced on low-flow oxygen at 0.05 litres/min, which improves both pre-ductal and post-ductal SpO₂ to 95%. Following this, the baby undergoes a chest radiograph which reveals a left sided pneumothorax with no significant lung collapse or mediastinal shift. As this is an incidental finding and the baby shows no clinical or radiological signs of tension pneumothorax, you question the need to treat with higher concentration oxygen therapy as has previously been routine practice.

Structured clinical question

In term and late preterm neonates (≥ 34 weeks) with spontaneous pneumothorax (SP) without clinical or radiological signs of tension (patient), is high concentration oxygen therapy (intervention) more effective than oxygen titrated to maintain targeted SpO₂ (comparison) for resolution/ improvement of clinical symptoms (outcome)?

Search

A literature search on Medline took place on 15th March 2018 using the following terms: exp "INFANT/NEWBORN"/, OR (neonate* OR newborn* OR neonatal OR babies OR baby OR infant*), AND exp PNEUMOTHORAX/, OR (pneumothorax OR pneumothoracis OR pneumothoraces), AND exp "CONSERVATIVE TREATMENT"/, (conservative ADJ (management OR therapy OR treatment)). This returned 33 results. There were only 2 studies in neonatal population (Table 1) that looked at high concentration oxygen therapy versus targeted oxygen therapy or room air^{2,3}.

Commentary

Spontaneous pneumothorax is a common air leak syndrome with incidence of 0.05-2% in all live births⁴. Management of neonatal pneumothorax is dependent on severity of signs and symptoms, air leak size and evidence of lung collapse and/or mediastinal shift on chest radiographs. For pneumothoraces that show no evidence of cardiorespiratory instability or chest radiograph suggesting tension, invasive procedures such as needle thoracocentesis and/ or chest drain placement are not routinely performed². There are a range of conservative management practices to manage neonates with non-tension pneumothorax which may include; observation only, oxygen therapy to maintain targeted SpO₂, non-invasive respiratory support, or the use of 100% inspired oxygen for 'nitrogen washout'^{6,7}. Nitrogen washout is thought to help with resolution of pneumothorax by increasing the nitrogen absorption gradient from the extra-pulmonary space. However, there is concerning evidence in literature of detrimental effects of oxygen therapy secondary to free radical injury^{8,9}.

A retrospective review by Clark et al² showed that 100% oxygen therapy until resolution of radiological pneumothorax, was no better than targeted oxygen therapy to maintain SpO₂ between 92-95%, in the treatment of symptomatic small to moderate pneumothoraces, with evidence of respiratory distress but no signs of tension. In the retrospective review, the use of 100% oxygen demonstrated significant prolonged need for oxygen therapy and time to establish full feeds. These neonates also had longer time to resolution of tachypnoea and hospitalisation, however this was not statistically significant. The authors stated that a prospective randomised control trial may not be ethical due to the potential

toxicity of 100% oxygen therapy and have recommended the use of oxygen to target accepted oxygen saturations.

The study by Shaireen et al³ included a larger sample size from multiple centres. Overall they showed no statistical difference in the time of resolution of symptoms and length of hospital stay of spontaneous non-tension pneumothorax for the three treatment groups classified as receiving high oxygen (>60% FiO₂), moderate oxygen (<60% FiO₂) or room air (21%). The retrospective cohort study showed that the neonates in the room air group did not have any clinical deterioration and therefore the authors have stated that room air may be as effective as high oxygen in resolution of spontaneous pneumothorax.

Through our review of available evidence, there is a lack of trials comparing different non-invasive strategies in non-tension SP, especially with regards to high oxygen concentration and targeted oxygen therapy. Only two studies specifically answered our clinical question. Overall, there is no evidence in the neonatal literature to support high concentration oxygen therapy in term or late preterm (≥34 weeks) neonates with non-tension pneumothorax, despite it being used commonly in practice.

Clinical bottom line

- High concentration oxygen does not show greater benefit over targeted oxygen therapy to help early resolution of neonatal non-tension pneumothorax and may potentially be harmful due to free radical damage (Grade D)
- Neonates who receive high oxygen therapy may take longer to establish feeds (Grade D)

Table 1: Summary of Evidence

Citation	Study group	Study type (level of evidence)	Outcome	Key results	Comments
Clark et al ² 2014	45 babies >35 weeks gestation, with small to moderate spontaneous pneumothoraces (SP) that did not require chest tube drainage and/or ventilatory support ; 100% oxygen therapy, nitrogen washout group (NW)=26 Versus Oxygen treatment with targeted pulse oximetry, conventional group (C) =19	Retrospective cohort study (level 4)	Primary Outcomes: Time to resolution of respiratory distress and length of oxygen therapy Secondary Outcomes: time to full feeding and length of hospital stay	NW group versus C group Time to resolution of tachypnoea: 37 (±27) vs 20 (±26) hours (NS); Length of oxygen treatment: 21.3 vs 8 hours, P < 0.001 (S); Time to full feeds: 44.1 ± 25.7 vs 29.5 ± 18.8 hours, P = 0.03 (S); Length of hospitalization: 4.35 ±1.96 vs 3.53 ± 1.68 (NS)	No advantages of 100% oxygen therapy as compared to oxygen saturation targeted therapy in SP
Shaireen et al ³ 2014	92 term neonates with radiologically confirmed SP treated with; high oxygen concentrations (HO: FiO ₂ ≥ 60%) =27, moderate oxygen concentrations (MO: FiO ₂ < 60%)=35, room air (RA: FiO ₂ = 21%)= 30	Population based retrospective multicentre, cohort study (level 4)	Primary Outcome: Time to clinical resolution of SP Secondary Outcome: Length of hospital stay and treatment failure	The time to resolution of SP between the three groups, median (range 25th-75th percentile) for HO = 12 hr (8-27), MO = 12 hr (5-24) and RA = 11 hr (4-24), p = 0.5 (NS) Treatment failure: HO: 2, MO:4, RA: 0, p 0.17 (NS) Length of Hospital Stay p 0.54 (NS)	Neonates treated with room air did not require supplemental oxygen during their admission and remained stable

NS = Non-significant, S = Significant

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